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Characterization of damaged skin by impedance spectroscopy: chemical damage by dimethyl sulfoxide

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Abstract

Purpose: To relate changes in the electrochemical impedance spectra to the progression and mechanism of skin damage arising from exposure to dimethyl sulfoxide (DMSO).

Methods: Electrochemical impedance spectra measured before and after human cadaver skin was treated with neat DMSO or phosphate buffered saline (control) for 1 h or less were compared with electrical circuit models representing two contrasting theories describing the progression of DMSO damage. Flux of a model lipophilic compound (p-chloronitrobenzene) was also measured.

Results: The impedance spectra collected before and after 1 h treatment with DMSO were consistent with a single circuit model; whereas, the spectra collected after DMSO exposure for 0.25 h were consistent with the model circuits observed before and after DMSO treatment for 1 h combined in series. DMSO treatments did not significantly change the flux of p-chloronitrobenzene compared to control.

Conclusions: Impedance measurements of human skin exposed to DMSO for less than about 0.5 h were consistent with the presence of two layers: one damaged irreversibly and one unchanged. The thickness of the damaged layer increased proportional to the square-root of treatment time until about 0.5 h, when DMSO affected the entire stratum corneum. Irreversible DMSO damage altered the lipophilic permeation pathway minimally.

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